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If the function  $\overline{\cos \theta + \theta}$  be denoted by  $C(\theta)$  this equation can be written

$$2m = C(\phi + u) - C(\phi - u) \quad . \quad . \quad . \quad (4)$$

If a table be formed giving the values of  $C(\theta)$  for all values of  $\theta$ , at small intervals, within such limits as to cover all required values of  $\phi - u$  and  $\phi + u$ , the value of  $m$  is known when that of  $u$  is given. It is only requisite to take the two values of  $C(\theta)$  corresponding to  $\theta = \phi + u$  and  $\theta = \phi - u$ , from the table, subtract the latter from the former, and halve the difference. The determination of  $u$  when  $m$  is given is effected by finding two consecutive values of  $u$  such that, for one of them, the value of  $C(\phi + u) - C(\phi - u)$  falls short of, and for the other, exceeds,  $2m$ . The method of proportional parts will then give the sought value of  $u$  with all requisite exactness.

NOTE.—The paper of which the foregoing is a brief abstract was accompanied by a specimen of the proposed table, in which the argument is given (for every minute of arc) from  $28^{\circ} 0'$  to  $31^{\circ} 0'$ ; and in which the function is given in seconds of arc and tenths of a second, with a difference column.

## PLANETARY PHENOMENA FOR SEPTEMBER AND OCTOBER, 1895.

BY PROFESSOR MALCOLM McNEILL.

### SEPTEMBER.

The autumnal equinox occurs, and the Sun crosses the equator from the north to the south, on September 22d, at about 11 P.M., Pacific time.

*Eclipses.* There will be two during the month.

(1.) *An Eclipse of the Moon* on the evening of September 3d. It will be total, and the entire eclipse will be visible throughout the United States. The times of the phases are as follows (P. S. T.):

|                        |          | H. M.     |
|------------------------|----------|-----------|
| Moon enters penumbra,  | Sept. 3, | 6 48 P.M. |
| Moon enters shadow,    | " 3,     | 8 0       |
| Total eclipse begins,  | " 3,     | 9 6       |
| Middle of the eclipse, | " 3,     | 9 57      |
| Total eclipse ends,    | " 3,     | 10 47     |
| Moon leaves shadow,    | " 3,     | 11 54     |
| Moon leaves penumbra,  | " 4,     | 1 6 A.M.  |

(2.) *A Partial Eclipse of the Sun* on September 18th. It will be visible only over a portion of the southern hemisphere. It may be seen wholly or in part in Eastern Australia, New Zealand, and the Fiji Islands.

*Mercury* is an evening star throughout the month, gradually moving out toward east elongation; but, on account of its great distance south of the sun, it will not be favorably situated for naked-eye observation. At the end of the month it sets about 50<sup>m</sup> later than the Sun. On September 1st it passes 1' south of *Mars*, but the conjunction occurs while both planets are below our horizon in the early morning.

*Venus* is an evening star, but too near the Sun to be easily seen at the beginning of the month. It is in conjunction with the Sun on September 16th, and becomes a morning star. At the end of the month it rises rather more than an hour before the Sun.

*Mars* is also an evening star, but too close to the Sun to be seen. On September 1st it sets less than half an hour later, and at the end of the month only 10<sup>m</sup> later than the Sun.

*Jupiter* is a morning star, and is getting far enough away from the Sun to be a conspicuous object for early risers. At the end of the month it rises a little after midnight. It moves 6° eastward during the month, and is in the constellation *Cancer*, not far from the "Bee-hive" cluster.

*Saturn* is an evening star, but is getting nearer the Sun, and at the end of the month remains above the horizon only a little more than an hour after sunset. It moves eastward in the constellation *Virgo* about 3°, passing north of the fourth-magnitude star *Lambda Virginis*. The nearest approach is on September 18th, when the planet is not quite 2° north of the star.

*Uranus* is also in the southwestern sky in the evening. It is in the constellation *Libra*, and moves eastward and northward about 1½°. The nearest naked-eye star, *Iota Libræ*, fifth magnitude, is 1° east and 2½° south of the planet.

*Neptune* is in the constellation *Taurus*, and by the end of the month rises a little before midnight.

#### OCTOBER.

*Mercury* is an evening star until October 25th, when it passes inferior conjunction with the Sun, and becomes a morning star. It passes greatest east elongation on October 1st, when it is not

quite  $26^{\circ}$  east of the Sun; but, on account of its great southern declination (it is  $12^{\circ}$  south of the Sun), the conditions for visibility in the northern hemisphere are rather poor. At this elongation it sets about  $50^m$  later than the Sun.

*Venus* is now a morning star, rapidly increasing its distance from the Sun, and moving eastward and northward. On October 1st it rises more than an hour before sunrise, and on October 31st about three and one-half hours before. It moves from the constellation *Leo* into *Virgo*. Toward the close of the month it attains its maximum brightness, and will be brilliant enough to be seen in full daylight, without telescopic aid, if one only knows where to look for it.

*Mars* is apparently very near the Sun, setting just after sunset on October 1st, and rising a few minutes before sunrise on October 31st. It is in conjunction with the Sun on the morning of October 11th. It had passed its maximum distance from the Earth about three weeks earlier; at that time it was about 244,000,000 miles from the earth—more than six times its distance at the opposition of October, 1894,—and the light it gives us is only about one-fortieth as much.

*Jupiter* is getting into better position. By the end of the month it rises at about 11 P.M. During the month it moves about  $4^{\circ}$  eastward through the constellation *Cancer*. It moves from a position a little south of the "Bee-hive" cluster, passing  $19'$  south of the fifth-magnitude star *Delta Cancr*i on October 19th.

*Saturn* has ceased to be a conspicuous object. On October 1st it sets about  $1^h 20^m$  after the Sun, and at the end of the month only about a quarter of an hour later. It will not be possible to follow it with the naked eye more than a few days after the beginning of the month. When it comes into good position for early morning observation on the other side of the Sun, the rings will be perceptibly wider open than they have been during the last few months. It moves eastward about  $3^{\circ}$  in the constellation *Virgo*.

*Uranus* is also drawing nearer the Sun, setting less than two hours later on October 1st. On account of its small magnitude (about sixth), it will not be easy to see it much after the beginning of the month. During the month it moves more than  $1^{\circ}$  eastward in the constellation *Libra*.

*Neptune* is in the eastern part of the constellation *Taurus*, and is well above the horizon some time before midnight. As it is

of the eighth magnitude, it requires a telescope to show it, and it cannot readily be found without the use of setting-circles on the telescope.

#### EXPLANATION OF THE TABLES.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1<sup>m</sup>. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

#### PHASES OF THE MOON, P. S. T.

|                |           | H. M.       |  |
|----------------|-----------|-------------|--|
| Full Moon,     | Sept. 3,  | 9 55 P. M.  |  |
| Last Quarter,  | Sept. 11, | 8 51 P. M.  |  |
| New Moon,      | Sept. 18, | 12 55 P. M. |  |
| First Quarter, | Sept. 25, | 10 23 A. M. |  |

#### THE SUN.

|          | R. A. | Declination. | Rises.     | Transits.   | Sets.      |
|----------|-------|--------------|------------|-------------|------------|
| 1895.    | H. M. | ° '          | H. M.      | H. M.       | H. M.      |
| Sept. 1. | 10 42 | + 8 17       | 5 29 A. M. | 12 0 M.     | 6 31 P. M. |
| 11.      | 11 18 | + 4 34       | 5 39       | 11 57 A. M. | 6 15       |
| 21.      | 11 54 | + 0 42       | 5 48       | 11 53       | 5 58       |
| Oct. 1.  | 12 30 | - 3 12       | 5 58       | 11 50       | 5 42       |

*MERCURY.*

| 1895.    | R. A. |    | Declination. |       | Rises. |    | Transits. |       | Sets. |          |
|----------|-------|----|--------------|-------|--------|----|-----------|-------|-------|----------|
|          | H.    | M. | °            | '     | H.     | M. | H.        | M.    | H.    | M.       |
| Sept. 1. | 11    | 31 | +            | 4 1   | 6      | 33 | A.M.      | 12 50 | P.M.  | 7 7 P.M. |
| 11.      | 12    | 28 | —            | 3 27  | 7      | 15 |           | 1 7   |       | 6 59     |
| 21.      | 13    | 18 | —            | 10 6  | 7      | 51 |           | 1 18  |       | 6 45     |
| Oct. 1.  | 14    | 2  | —            | 15 22 | 8      | 12 |           | 1 22  |       | 6 32     |

*VENUS.*

|          |    |    |   |      |      |      |       |      |      |      |
|----------|----|----|---|------|------|------|-------|------|------|------|
| Sept. 1. | 12 | 2  | — | 8 5  | 7 44 | A.M. | 1 20  | P.M. | 6 56 | P.M. |
| 11.      | 11 | 48 | — | 7 58 | 6 50 |      | 0 27  |      | 6 4  |      |
| 21.      | 11 | 27 | — | 5 42 | 5 43 |      | 11 27 | A.M. | 5 11 |      |
| Oct. 1.  | 11 | 11 | — | 2 27 | 4 36 |      | 10 31 |      | 4 26 |      |

*MARS.*

|          |    |    |   |      |      |      |       |      |      |      |
|----------|----|----|---|------|------|------|-------|------|------|------|
| Sept. 1. | 11 | 31 | + | 4 4  | 6 33 | A.M. | 12 50 | P.M. | 7 7  | P.M. |
| 11.      | 11 | 55 | + | 1 27 | 6 26 |      | 12 34 |      | 6 42 |      |
| 21.      | 12 | 19 | — | 1 12 | 6 19 |      | 12 18 |      | 6 17 |      |
| Oct. 1.  | 12 | 43 | — | 3 51 | 6 13 |      | 12 3  |      | 5 53 |      |

*JUPITER.*

|          |   |    |   |       |       |      |      |      |      |      |
|----------|---|----|---|-------|-------|------|------|------|------|------|
| Sept. 1. | 8 | 6  | + | 20 33 | 2 8   | A.M. | 9 25 | A.M. | 4 42 | P.M. |
| 11.      | 8 | 14 | + | 20 10 | 1 39  |      | 8 54 |      | 4 9  |      |
| 21.      | 8 | 22 | + | 19 47 | 1 8   |      | 8 22 |      | 3 36 |      |
| Oct. 1.  | 8 | 28 | + | 19 26 | 12 37 |      | 7 49 |      | 3 1  |      |

*SATURN.*

|          |    |    |   |       |      |      |      |      |      |      |
|----------|----|----|---|-------|------|------|------|------|------|------|
| Sept. 1. | 14 | 7  | — | 10 28 | 9 58 | A.M. | 3 25 | P.M. | 8 52 | P.M. |
| 11.      | 14 | 11 | — | 10 48 | 9 23 |      | 2 49 |      | 8 15 |      |
| 21.      | 14 | 14 | — | 11 9  | 8 49 |      | 2 14 |      | 7 39 |      |
| Oct. 1.  | 14 | 19 | — | 11 32 | 8 14 |      | 1 38 |      | 7 2  |      |

*URANUS.*

|          |    |    |   |       |       |      |      |      |      |      |
|----------|----|----|---|-------|-------|------|------|------|------|------|
| Sept. 1. | 14 | 56 | — | 16 29 | 11 8  | A.M. | 4 14 | P.M. | 9 20 | P.M. |
| 11.      | 14 | 58 | — | 16 35 | 10 31 |      | 3 36 |      | 8 41 |      |
| 21.      | 15 | 0  | — | 16 43 | 9 54  |      | 2 59 |      | 8 4  |      |
| Oct. 1.  | 15 | 2  | — | 16 51 | 9 17  |      | 2 21 |      | 7 25 |      |

*NEPTUNE.*

|          | R. A. |    | Declination. |    | Rises. |        | Transits. |         | Sets. |         |
|----------|-------|----|--------------|----|--------|--------|-----------|---------|-------|---------|
|          | H.    | M. | °            | '  | H.     | M.     | H.        | M.      | H.    | M.      |
| 1895.    |       |    |              |    |        |        |           |         |       |         |
| Sept. 1. | 5     | 8  | + 21         | 28 | 11     | 6 P.M. | 6         | 27 A.M. | 1     | 48 P.M. |
| 11.      | 5     | 9  | + 21         | 28 | 10     | 27     | 5         | 48      | 1     | 9       |
| 21.      | 5     | 9  | + 21         | 28 | 9      | 48     | 5         | 9       | 12    | 30      |
| Oct. 1.  | 5     | 9  | + 21         | 27 | 9      | 9      | 4         | 30      | 11    | 51 A.M. |

PHASES OF THE MOON, P. S. T.

|                |          | H. | M.       |
|----------------|----------|----|----------|
| Full Moon,     | Oct. 3,  | 2  | 47 P. M. |
| Last Quarter,  | Oct. 11, | 6  | 34 A. M. |
| New Moon,      | Oct. 17, | 10 | 10 P. M. |
| First Quarter, | Oct. 25, | 3  | 4 A. M.  |

THE SUN.

|         | R. A. |    | Declination. |    | Rises. |         | Transits. |         | Sets. |         |
|---------|-------|----|--------------|----|--------|---------|-----------|---------|-------|---------|
|         | H.    | M. | °            | '  | H.     | M.      | H.        | M.      | H.    | M.      |
| 1895.   |       |    |              |    |        |         |           |         |       |         |
| Oct. 1. | 12    | 30 | — 3          | 12 | 5      | 58 A.M. | 11        | 50 A.M. | 5     | 42 P.M. |
| 11.     | 13    | 6  | — 7          | 2  | 6      | 8       | 11        | 47      | 5     | 26      |
| 21.     | 13    | 43 | — 10         | 43 | 6      | 19      | 11        | 45      | 5     | 11      |
| 31.     | 14    | 22 | — 14         | 8  | 6      | 30      | 11        | 44      | 4     | 58      |

*MERCURY.*

|         |    |    |      |    |   |         |    |         |   |         |
|---------|----|----|------|----|---|---------|----|---------|---|---------|
| Oct. 1. | 14 | 2  | — 15 | 22 | 8 | 12 A.M. | 1  | 22 P.M. | 6 | 32 P.M. |
| 11.     | 14 | 29 | — 18 | 14 | 8 | 10      | 1  | 9       | 6 | 8       |
| 21.     | 14 | 18 | — 16 | 7  | 7 | 12      | 12 | 19      | 5 | 26      |
| 31.     | 13 | 39 | — 9  | 19 | 5 | 31      | 11 | 2 A.M.  | 4 | 33      |

*VENUS.*

|         |    |    |     |    |   |         |    |         |   |         |
|---------|----|----|-----|----|---|---------|----|---------|---|---------|
| Oct. 1. | 11 | 11 | — 2 | 27 | 4 | 36 A.M. | 10 | 31 A.M. | 4 | 26 P.M. |
| 11.     | 11 | 8  | + 0 | 8  | 3 | 45      | 9  | 49      | 3 | 53      |
| 21.     | 11 | 19 | + 1 | 12 | 3 | 13      | 9  | 21      | 3 | 29      |
| 31.     | 11 | 41 | + 0 | 48 | 2 | 58      | 9  | 3       | 3 | 8       |

*MARS.*

|         |    |    |      |    |   |         |    |         |   |         |
|---------|----|----|------|----|---|---------|----|---------|---|---------|
| Oct. 1. | 12 | 43 | — 3  | 51 | 6 | 13 A.M. | 12 | 3 P.M.  | 5 | 53 P.M. |
| 11.     | 13 | 7  | — 6  | 28 | 6 | 5       | 11 | 47 A.M. | 5 | 29      |
| 21.     | 13 | 32 | — 9  | 2  | 6 | 0       | 11 | 33      | 5 | 6       |
| 31.     | 13 | 57 | — 11 | 31 | 5 | 55      | 11 | 19      | 4 | 43      |

*JUPITER.*

## THE SUN.

| 1895. |     | R. A. | Declination. | Rises.     | Transits. | Sets.    |
|-------|-----|-------|--------------|------------|-----------|----------|
|       |     | H. M. |              | H. M.      | H. M.     | H. M.    |
| Oct.  | I.  | 8 28  | + 19 26      | 12 37 A.M. | 7 49 A.M. | 3 1 P.M. |
|       | 11. | 8 34  | + 19 7       | 12 4       | 7 15      | 2 26     |
|       | 21. | 8 39  | + 18 51      | 11 31 P.M. | 6 41      | 1 51     |
|       | 31. | 8 43  | + 18 39      | 10 57      | 6 5       | 1 13     |

*SATURN.*

|      |     |       |         |           |            |          |
|------|-----|-------|---------|-----------|------------|----------|
| Oct. | I.  | 14 19 | - 11 32 | 8 14 A.M. | 1 38 P.M.  | 7 2 P.M. |
|      | 11. | 14 23 | - 11 55 | 7 40      | 1 3        | 6 26     |
|      | 21. | 14 27 | - 12 18 | 7 8       | 12 29      | 5 50     |
|      | 31. | 14 32 | - 12 41 | 6 34      | 11 54 A.M. | 5 14     |

*URANUS.*

|      |     |      |         |           |           |           |
|------|-----|------|---------|-----------|-----------|-----------|
| Oct. | I.  | 15 2 | - 16 51 | 9 17 A.M. | 2 21 P.M. | 7 25 P.M. |
|      | 11. | 15 4 | - 17 0  | 8 40      | 1 44      | 6 48      |
|      | 21. | 15 6 | - 17 10 | 8 3       | 1 7       | 6 11      |
|      | 31. | 15 8 | - 17 20 | 7 27      | 12 30     | 5 33      |

*NEPTUNE.*

|      |     |     |         |          |           |            |
|------|-----|-----|---------|----------|-----------|------------|
| Oct. | I.  | 5 9 | + 21 27 | 9 9 P.M. | 4 30 A.M. | 11 51 A.M. |
|      | 11. | 5 8 | + 21 27 | 8 29     | 3 50      | 11 11      |
|      | 21. | 5 8 | + 21 26 | 7 49     | 3 10      | 10 31      |
|      | 31. | 5 7 | + 21 24 | 7 9      | 2 30      | 9 51       |

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ECLIPSE OF *JUPITER'S* FOURTH SATELLITE, 1895,  
APRIL 11.

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By JOHN TEBBUTT, F. R. A. S.

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It is not often that one can get an observation of this satellite in eclipse, and still more rare is an observation at the beginning or end of a cycle of eclipses. It was pointed out by Mr. Marth (R. A. S. *Monthly Notices*, Vol. LIV, p. 587) that the first eclipse of the current cycle would occur on February 2d; and he recommended Australian observers to be on the watch in order to